

The greatest monthly precipitation in the district was 10.35 inches at Homestead, Fla., which was the only station reporting as much as 10 inches. Pascagoula, Miss., received 8.24 and Lafayette, Ga., 7.30 inches. The least monthly rainfall was 0.22 inch at Aberdeen, Miss., closely followed by Columbia, Va., with 0.23, and Dadeville, Ala., with 0.30. Excessive precipitation occurred at but few places during the month; the following are the most important records: Danville, Va., reported 2.68 inches in 24 hours on the 2-3d; at Greenville, N. C., 4.34 inches fell in 10 hours on the 9-10th, the heaviest rainfall on record at that station; at Willard, N. C., 2.08 inches fell in 30 minutes on the 24th; Allendale, S. C., reported 4.00 inches on the 30th and Clemson College 4.31 on the 1st; Adairsville, Ga., 4.02 inches on the 1st and Lafayette 3.15 on the 8-9th; the maximum fall in Florida was 3.88 inches at Switzerland on the 26th; in Alabama, 3.37 at Bermuda on the 5th; and in Mississippi, 4.15 at Pascagoula on the 9th. The average number of days with rain was 7. A moderate number of thunderstorms occurred, and hail was reported at a few points.

#### RIVER CONDITIONS.

At the beginning of the month the rivers in the district were all rising under the influence of the general rains from the 1st to 3d, but as the remainder of the month was relatively very dry low stages prevailed throughout most of the month, and river conditions presented no features of special interest. A moderate rise occurred on the Roanoke River at Weldon, N. C., on the 5th, for which warnings were issued for the benefit of railroad bridge builders at that point. The rivers reached flood stages in the Wateree at Camden, S. C., on the 3d and in the Santee at Ferguson and Rimini on the 7th and 8th, but no damage of any kind resulted. River stages were below the normal in the rivers of Georgia, Alabama, and Mississippi during nearly the entire month.

#### MISCELLANEOUS PHENOMENA.

The prevailing winds in the district were from the northeast in all States, except Alabama and Mississippi, where they were from the east and north, respectively. The wind movement was small everywhere in the district. An average hourly velocity exceeding 10 miles occurred only at Hatteras, N. C. (average hourly velocity 13.8 miles), and at Pensacola, Fla. (10.7 miles). These two stations were also the only ones that reported maximum velocities exceeding 40 miles, viz: Hatteras, 44 miles from the northwest on the 14th, and Pensacola, 48 miles from the southeast on the 12th. The number of clear days was uniformly about 16 in all portions of the district, the number of cloudy days but 5; in South Carolina and Florida there were on the average but 3 cloudy days. No local storms of sufficient importance to deserve special mention were reported during September.

#### AVERAGE STREAM FLOW OF THE SANTEE RIVER SYSTEM IN SOUTH CAROLINA.

By J. W. BAUER, Section Director, Columbia, S. C.

The fan-shaped catchment basin of the group of rivers that empty into the Atlantic Ocean near Georgetown, S. C., through the Santee River, and commonly known as the Santee River system, includes the principal and by far the most numerous water-power sites in South Carolina. The system is composed of three main tributaries; namely, the Catawba-Wateree, Broad, and Saluda. The Catawba-Wateree on the north has a total length from its source to the ocean of 385 miles; the Broad, with its numerous small tributaries occupying the central position, is 307 miles long from its source to the ocean; the Saluda on the south occupies a much narrower valley, and has a length of 319 miles from its source to the ocean.

The Congaree, carrying the united waters of the Broad and the Saluda rivers, is about 52 miles long, but drains a comparatively small territory and has no water-power sites. The Santee River forms the handle of the fan-shaped basin and drains a strip of low-lying land about 119 miles long, and at no point over 30 miles wide, but as it carries the water of three fairly large rivers its discharge is always considerable, and at times of flood stages in its tributary rivers the volume of its discharge is very great. It has no power sites. On the Catawba River the principal water-power sites are located between the State line and Camden, S. C., the latter being the place where the river changes its name to Wateree. From Camden, S. C., to the mouth of the river there are no water-power sites. On the Broad River the power sites lie between the State line and Columbia, S. C., and on the Saluda River between Greenville, S. C., and Columbia, S. C. Many of the larger tributaries of these three rivers also afford water-power sites of considerable developed and estimated horsepower. Much of the potential power has been developed in recent years, mainly as large projects, but smaller potentialities on each of these rivers and their main tributaries still await development. Power to the amount of 165,803 horsepower has already been developed, distributed as follows: on the Catawba, 90,000; on the Broad, 54,813, and on the Saluda, 19,650. The Congaree is credited with 1,340 horsepower, but this properly belongs to the Broad River.

The variations in the flow of these rivers has been measured by gages on all the rivers in recent years, but only at Columbia, S. C., on the Congaree, Mount Holly, N. C., and Camden, S. C., on the Catawba-Wateree, and at St. Stephens, S. C., on the Santee, does the elapsed time since gage readings were begun afford reliable mean stage results, or establish with even approximate accuracy the relative frequency of flood stages or of extreme low water stages. The mean stages by months for each river gage station are given in the following tables:

#### Mean stages of the Saluda River.

PELZER, S. C.

This station is 109 miles above Columbia, S. C., at the mouth of the river. Length of record, 4 years. Flood stage, 7 feet. Drainage basin, 454 square miles.

Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
4.2	4.5	4.4	3.9	3.9	3.8	3.6	3.6	3.6	3.6	3.2	3.8

#### CHAPPELS, S. C.

This station is located 56 miles above Columbia, S. C., at the mouth of the river. Length of record, 5 years. Flood stage, 14 feet. Drainage basin, 1,318 square miles.

Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
6.1	6.4	5.9	4.5	4.6	5.3	5.9	4.8	4.1	3.4	3.1	5.4

#### Mean stages of the Broad River.

BLAIRS, S. C.

This station is located 36 miles above Columbia, S. C., at the mouth of the river. Length of record, 5 years. Flood stage, 14 feet. Drainage basin, 4,560 square miles.

Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
3.3	3.1	4.0	1.8	2.2	2.6	2.5	3.2	1.8	1.2	1.6	2.6

#### Mean stages of the Congaree River.

COLUMBIA, S. C.

This station is 52 miles above the junction of the Congaree and Wateree rivers. Length of record, 18 years. Flood stage, 15 feet. The drainage area above the station is 7,972 square miles.

Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
2.9	4.4	3.6	2.7	1.8	2.6	1.9	2.8	1.8	1.2	1.3	2.1

*Mean stages of the Catawba-Wataree River.***MOUNT HOLLY, N. C.**

This station is 143 miles above the mouth of the river, and drains an area of 1,774 square miles above the station. Length of record, 10 years. Flood stage, 15 feet.

Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
2.3	2.5	2.5	2.2	2.2	2.3	2.2	2.4	2.2	2.0	1.9	2.1

**CATAWBA, S. C.**

This station is 107 miles from the mouth of the river, and the drainage area above the station is 3,634 square miles. Length of record, 4 years. Flood stage, 11 feet.

Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
4.1	4.4	4.0	3.2	3.6	3.6	4.0	4.9	4.5	4.6	3.3	4.0

**CAMDEN, S. C.**

This station is 54 miles from the mouth of the river, and the area drained above the station is 5,319 square miles. Length of record, 19 years. Flood stage, 24 feet.

Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
9.6	11.9	11.2	8.7	7.7	8.8	7.9	9.0	7.3	6.9	6.2	8.0

*Mean stages of the Santee River.***RIMINI, S. C.**

This station is 108 miles from the mouth of the river, and is 11 miles from the junction of the Congaree and Wataree rivers. Length of record, 4 years. Flood stage, 12 feet. Drainage area above station, 14,551 square miles.

Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
11.1	12.2	11.7	9.2	9.8	11.4	10.6	11.4	10.0	8.5	8.4	10.2

**FERGUSON, S. C.**

This station is 78 miles from the mouth of the river. Length of record, 3 years. Flood stage, 12 feet. Drainage area above the station is 14,810 square miles.

Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
11.5	12.6	12.4	10.3	10.5	11.3	11.9	11.6	10.6	8.8	9.7	10.6

**ST. STEPHENS, S. C.<sup>1</sup>**

This station is 50 miles from the mouth of the river. Length of record, 16 years. Flood stage, 10 feet. The drainage area above the station is 15,307 square miles.

Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
6.5	7.9	7.9	7.1	5.7	5.3	5.3	5.8	4.9	3.5	4.5	5.5

<sup>1</sup> This station was closed August 31, 1907.

The extreme high and low water stages are well established by the gage readings at those stations whose records go back to the year 1900, or an earlier date, as the period between that year and the present one includes both the driest autumn and the heaviest rainfall of record in the watershed of the Santee system.

Stations.	Rivers.	Highest.	Date.	Lowest.	Date.
Pelzer, S. C.	Saluda	14.0	Aug. 26, 1908	1.8	Sept. 6, 7, 8, 1907.
Chappells, S. C.	do.	34.7	Aug. 26, 1908	0.7	Nov. 7, 1905.
Blairs, S. C.	Broad	31.0	Aug. 27, 1908	0.0	June 27, 1905.
Columbia, S. C.	Congaree	35.8	Aug. 27, 1908	- 3.0	Oct. 5, 1904.
Mount Holly, N. C.	Catawba	14.2	Aug. 26, 1908	0.2	June 28, 1890.
Catawba, S. C.	do.	25.4	Aug. 25, 1908	1.3	Oct. 4, 1908.
Camden, S. C.	Wataree	39.7	Aug. 26, 1908	0.9	July 5, 1898.
Rimini, S. C.	Santee	33.8	Aug. 30, 1908	2.9	Oct. 29, 1907.
Ferguson, S. C.	do.	23.7	Aug. 31, 1908	5.3	Dec. 1, 1909.
St. Stephens, S. C.	do.	15.6	Mar. 31, 1903	- 2.2	Oct. 26, 1904.

It will be noted that the highest water at all stations in operation at the time occurred during the flood of August, 1908. This was undoubtedly the greatest flood that has been experienced on the Santee River system in a century. Authentic flood stage records have been kept at Columbia, S. C., previous to the installation of a river gage, since 1840. The heights of

the previous flood stage marks have been reduced to equivalent readings on the river gage by lines of levels made by a competent civil engineer. The following list of high water stages include only those in which 30 feet or over were recorded namely, August, 1840, 33.7 feet; September, 1852, 34.4 feet; February, 1865, 34.0; May, 1885, 31.2 feet; June, 1886, 30.2 feet; September, 1888, 33.3 feet; August, 1908, 35.8 feet.

The different rivers of this system are variously susceptible to flood stages. The Saluda River at Pelzer, S. C., 49 miles from its source, has been above flood stage 19 days in the last 4 years; at Chappells, S. C., 102 miles from its source, there were 58 days with flood stage in the last 5 years. The Broad River at Blairs, S. C., 110 miles from its source, has been above flood stage 14 days in the last 5 years. The Congaree River at Columbia, S. C., has been above flood stage 87 days in the last 18 years. The Catawba River at Mount Holly, N. C., 123 miles from its source, has not been above flood stage in the last 10 years; on the same river at Catawba, S. C., 159 miles from its source, flood stage has been recorded on 28 days in the last 4 years; and at Camden, S. C. (Wataree River), 212 miles from its source, on 234 days in the last 19 years. The Santee River is bordered by extensive low swampy lands that are frequently flooded and remain so for considerable periods, owing mainly to the poor drainage; the record at Rimini, S. C., indicates 512 days in the last 4 years; at Ferguson, S. C., the record indicates 400 days in the last 3 years, while at St. Stephens, S. C., the eleven-year record (1896-1907) indicates but 289 days, being an average of 26 days to the year as compared with 128 and 133 days at Rimini and Ferguson, respectively. The difference between St. Stephens and the other points on the Santee River, is that the former does not include the great flood of August, 1908.

A summary by months of the number of days above flood stage indicates that the largest number of floods occur in February, the second largest number in March, and the third largest in August; also, that the smallest number of floods occur in November and the next smallest number in October. The following table<sup>1</sup> gives the relative frequency of floods by months:

Stations.	Length of record, years.	Flood stage, feet.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
Pelzer, S. C.	4	7	1	0	1	1	3	4	3	2	1	3	0	0
Chappells, S. C.	5	14	14	2	7	0	3	6	6	0	0	0	3	13
Blairs, S. C.	5	14	2	1	1	0	0	0	0	5	0	0	0	2
Columbia, S. C.	12	15	15	21	10	10	2	6	3	9	3	2	0	6
Mount Holly, N. C.	10	15	0	0	0	0	0	0	0	0	0	0	0	0
Catawba, S. C.	4	11	2	4	1	0	2	4	0	7	1	4	0	3
Camden, S. C.	19	24	26	43	32	16	13	17	8	31	14	17	1	16
Rimini, S. C.	4	12	43	67	66	25	27	44	49	55	47	31	22	31
Ferguson, S. C.	3	12	55	89	49	32	34	32	36	30	26	3	24	10
St. Stephens, S. C.	11	10	20	88	51	28	10	25	7	15	31	5	2	7

The average precipitation for western South Carolina, in the catchment basin of the Santee River system, has been determined from rainfall measurements at about 20 stations, whose lengths of records cover varying periods ranging from 6 to 20 years, including the year 1909. Regardless of length of record the data at each station shows an almost uniform annual double curve having a February maximum, an April minimum, and a greater August maximum and a lower October-November minimum. About 33 per cent of the annual precipitation falls in June, July, and August. There is a close relation between the rainfall and the mean river stages. The occurrence of floods is also closely correlated with these curves of maxima and minima precipitation, except that the run-off is greater for the winter than for the summer rainfall. The winter rains are usually general over the entire watershed, while the summer rains are mostly convectional being heavy to excessive only in

<sup>1</sup> Includes data to December 31, 1909.

small areas. When, however, the rain is at all general over the watershed in the summer, destructive floods are almost certain to occur. The highest flood waters almost without exception, have occurred late in the spring, during the summer, or early in the autumn. In the following tables the average precipitation by months is given for the drainage basin of each river, but for the Congaree River the averages for all stations in the Broad and Saluda river watersheds are combined and for the Santee River the averages include all the measurements that have been made in the entire Santee River system.

*Normal precipitation.*

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Saluda Basin.....	3.78	5.30	4.45	3.28	3.68	4.75	5.26	5.85	3.94	2.77	2.81	3.96
Broad Basin.....	3.48	4.92	4.32	3.15	3.64	4.65	4.59	6.03	3.57	2.90	2.58	3.76
Congaree Basin.....	3.61	5.07	4.31	3.18	3.61	4.64	5.11	6.04	3.74	2.82	2.65	3.76
Catawba-Wateree Basin.	3.63	4.26	4.15	3.15	4.24	4.90	5.25	6.06	3.74	2.96	2.66	3.91
Santee Basin.....	3.48	4.85	4.08	3.14	3.75	4.93	5.17	6.19	3.66	2.76	2.51	3.69

In an article written by Mr. M. O. Leighton, Chief Hydrographer, and published in Section 87, Western South Carolina, Summary of the Climatological Data for the United States, there are tables giving the discharge in cubic feet per second of some of the rivers of the Santee River system summarizing the measurements that have been made to and including the year 1908. The averages are reproduced herewith in the short tables. Another table is added for Columbia, S. C., on the Congaree, where the measurements were made by the United States Assistant Engineers at various dates and for different stages of the river, but all for comparatively low water stages. The volume of flood discharge has never been determined, nor have measurements been made for extreme low water. The table does include the average flow as shown by the table of mean stages:

*Discharge of Saluda River at Waterloo, S. C., 1899-1905, inclusive, drainage area, 1,060 square miles.*

	Discharge in cubic feet per second.		
	Maximum.	Minimum.	Per square mile.
Average for the period .....	19,000	200	1.91

*Discharge of Broad River at Alston, S. C., 1899-1907, inclusive, drainage area, 4,610 square miles.*

	Discharge in cubic feet per second.		
	Maximum.	Minimum.	Per square mile.
Average for the period.....	131,000	785	1.84

*Discharge of Catawba River at Morganton, N. C., period June 19, 1900, to 1908, inclusive, except 1901, 1902, and July and December, 1906, drainage area, 758 square miles.*

	Discharge in cubic feet per second.		
	Maximum.	Minimum.	Per square mile.
Average for the period .....	28,400	280	2.03

*Discharge of Wateree River at Camden, S. C., period 1905-1908, inclusive, except August to December, 1908, drainage area, 2,640 square miles.*

	Discharge in cubic feet per second.		
	Maximum.	Minimum.	Per square mile.
Average for the period .....	29,600	690	2.79

*Current measurement of the Congaree River at Columbia, S. C.*

Date.	River gage.	Area, square feet	Discharge in cubic feet per second.
December 26, 1900 .....	2.4	2,881.1	9,393.3
December 27, 1900 .....	2.0	2,618.9	8,459.7
January 16, 1901.....	4.5	3,847.0	13,245.3
January 17, 1901.....	4.0	3,623.8	12,810.3
January 18, 1901.....	5.9	4,493.0	16,525.2

The estimated available horsepower developed by the rivers in this section, that drain into the Santee, is given in the following table. The table was prepared by Mr. Leighton.

River.	Section.	Minimum horsepower.	Six months' horsepower.
Wateree.....	Camden to State line.....	65,600	98,400
Broad.....	Mouth to Gaffney.....	66,600	99,900
Saluda.....	Mouth to North Saluda.....	41,400	53,800